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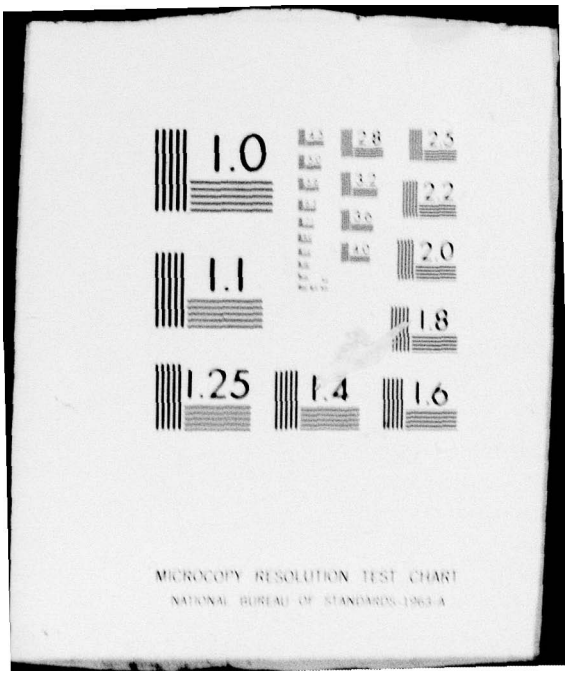
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Research Memorandum 66-2

RELATIVE EFFECTIVENESS OF DIFFERENT METHODS OF STATING IMAGE INTERPRETATION REQUIREMENTS

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(6) RELATIVE EFFECTIVENESS OF DIFFERENT METHODS OF STATING IMAGE INTERPRETATION REQUIREMENTS,

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THE RELATIVE EFFECTIVENESS OF DIFFERENT METHODS OF STATING IMAGE INTERPRETATION REQUIREMENTS

The Army Image Interpreter working in a tactical environment must be responsive to a number of interpretation requirements. Foremost among these requirements are those for accuracy and completeness of information. Problems arise when these requirements are imposed simultaneously. For example, if the requirement is for completeness of target identification (that is, all targets must be identified), interpreters may respond to doubtful cues and signatures, and achieve completeness at the sacrifice of accuracy. On the other hand, a requirement for high accuracy may lead interpreters to identify only the more discriminable targets, and to ignore doubtful ones. Simply instructing interpreters to be accurate and complete in all situations may not lead to the optimal information output for any particular situation.

Edwards[1] has proposed a solution to problems where the instructions may be ambiguous or may require working in accordance with conflicting purposes. His solution proposes setting up a payoff matrix and assigning values to each response as it relates to the true state. For example, identifying a tank as a truck vs. identifying a jeep as a tank. From the assigned costs and values, the interpreter can determine the approach which will maximize his performance in terms of his specific objective.

More recently signal detection theorists have utilized the payoff matrix approach to obtain differential performance in the detection of signals. Thomas and Sadacca,[2] using a modified payoff approach, found that interpreters can vary their performance in accordance with payoff instructions. In that study, however, the instructions to interpreters were a combination of the payoff, certitude, and verbal methods described below. The present study is concerned with the relative effectiveness of the three methods of stating instructions. The specific objective was to determine how the three methods of stating information requirements affect the accuracy and completeness of interpretation under each of three types of requirement--for accuracy, for completeness, and for accuracy and completeness combined.

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[1] Edwards, Ward. Payoffs are Instructions. Psychological Review. 68, 1961. p 275-284.

[2] Thomas, J. A. and Sadacca, R. Ability of image interpreters to adapt output to varying requirements for completeness and accuracy. Technical Research Note 165. U. S. Army Personnel Research Office. December 1965.

GENERAL APPROACH

INTERPRETATION REQUIREMENTS

The information requirements differed in the emphasis placed on three attributes:

1. Accuracy of target identification.
2. Completeness of target identification.
3. Accuracy and completeness of target identification combined.

METHODS OF STATING REQUIREMENTS

Payoff method. This method is a modification of the payoff matrix approach suggested by Edwards and others. Under this method, the interpreter is advised of the number of points which will be awarded for each correct identification or deducted as a penalty for each incorrect identification. In the present study, the interpreter was not told to be complete in his interpretation, or to be accurate, or to be complete and accurate. Instead, for each requirement, he was given a scoring formula--the payoff--for correct and incorrect responses to serve as the rule under which he was to operate.

For the accuracy requirement, the instructions stated that one point would be awarded for each correct identification and nine points would be deducted for each incorrect identification.

For the completeness requirement, the interpreter was informed that he would be given one point for each correct identification, and that no points would be subtracted for each incorrect identification.

For the accuracy and completeness requirement, the instructions stated that one point would be awarded for each correct identification, and one point subtracted for each incorrect identification.

Certitude Method. The interpreter was instructed to identify only those targets for which his level of confidence was above a stipulated figure. Level of confidence is an expression of the interpreter's feeling of certitude in his identification. For example, a confidence level of 90% indicates that the interpreter feels that he has a 90 percent or a 9 to 1 chance of being correct. Interpreters had been previously instructed in the use of levels of confidence.

Under the accuracy requirement, the interpreter was instructed to "only identify those targets for which your level of confidence is 90% or better".

Under the completeness requirement, the interpreter was instructed to "identify all the targets you possibly can, even if your level of confidence may be near zero".

Under the accuracy and completeness requirement, the interpreter was instructed to "only identify those targets for which your level of confidence is 50% or better".

Verbal Method. Under this method, the requirements were presented to the interpreter as verbal summary statements of the particular requirement.

Under the accuracy requirement, the interpreter was instructed to "be as highly accurate as possible in identifying the tactical targets".

For the completeness requirement, the interpreter was instructed to "be as complete as you can in identifying tactical targets".

Under the accuracy and completeness requirement, the interpreter was instructed to "be as complete and as accurate as possible in identifying tactical targets .."

A complete set of instructions used under the three methods is included as Appendix A. The methods and the instructions for each method used for each requirement is summarized in Table 1.

Table 1

SUMMARY OF PROCEDURES EMPLOYED IN EXPERIMENT

Method of Stating Requirements	Value Statement for Response Requirements	Image Interpretation Requirements		
		Completeness (T-17)	Completeness-Accuracy (T-10)	Accuracy (T-23)
Payoff	Score for rights	rights = +1	rights = +1	rights = +1
	Score for wrongs	wrongs = 0	wrongs = -1	wrongs = -9
Certitude	Minimum acceptable level of certitude	0%	50%	90%
Verbal	Description (Verbal)	Be very complete	Be accurate and complete	Be very accurate

EXPERIMENTAL METHOD

SUBJECT

Thirty image interpreter trainees in the last week of training at the U. S. Army Intelligence School, Ft. Holabird, Maryland, were used in this experiment. The sample was divided into three matched groups of ten each. The matching procedure was accomplished on the basis of Rights and Wrongs scores on three standard performance measures.

PERFORMANCE MEASURES

A series of 3 tactical performance measures, representing typical real-life work situations which confront the image interpreter, was selected for this experiment, T-10, T-17, and T-23. Imagery for the performance measures was selected from actual tactical and strategic air reconnaissance missions. Some photographs, taken during wartime, showed enemy-held positions.

As in the operational situation, the interpreters were provided with maps, sortie plot overlays, and standard references or photo keys for each performance measure. They were also given situation sheets showing the number of photographs included in the test, the scale of the photos, the specific request for information, and the general battlefield situation at the time the photos were obtained. The situation sheets for the three performance measures are given in Appendix B.

EXPERIMENTAL APPROACH

This experiment was designed to determine whether, for a given interpretation requirement, interpreter performance would vary as a function of different methods of stating the requirement. For each requirement, a different performance measure was used, T-17 for the completeness requirement, T-10 for accuracy and completeness, and T-23 for accuracy.

The design thus required three single-factor experiments, one experiment for each requirement. Each of the three groups was assigned to a method for a particular test. Each group was also administered the three performance measures in the same order in accordance with the assigned experimental method (See Appendix C for Raw Score Distribution).

Immediately prior to data collection, the situation sheet for a given measure was first read aloud to the subjects. After answering any questions raised by the subjects concerning their assignments, the military situation and the specific method under which the subjects in each group were to make their identifications was read. The subjects

then began interpreting the imagery. The subjects were allowed 50, 60, and 25 minutes to complete measures T-10, T-17, and T-23, respectively.

VARIABLES

The main concern of this experiment was to determine the effect of the methods of stating interpretation requirements on interpreter performance. The effect of the experimental methods employed for each requirement was determined for four dependent variables.

1. Number of targets correctly identified (R)

2. Number of targets incorrectly identified (W)

3. Accuracy of identification: $\frac{R}{(R + W)}$

4. Weighted accuracy score (XR-YW) where X equals the positive value assigned to each right score, and Y equals the negative value assigned to each wrong score for each requirement.

The weighted scores were included to determine the effects of the three methods where performance was actually scored in terms of the values given either explicitly or implicitly in the instructions, depending upon the method used. The weighted scores were computed using the values assigned to the payoff method (See Table 1) and weighting the raw scores for all methods accordingly. It was assumed that the instructions were fairly comparable across all methods for each requirement. Although the values used were explicit for the payoff method, to a degree sufficient for this exploratory study, they were implied in the instructions for the other methods.

The specific weights were assigned as follows:

	Image Interpretation Requirement		
Weights	Accuracy	Completeness	Accuracy & Completeness
Rights	+1	+1	+1
Wrongs	-9	0	-1

RESULTS

Table 2 shows the mean number of correct and incorrect identifications as well as the mean accuracy obtained under the completeness requirement. As is readily apparent from the consistency among the means of the different variables, none of the dependent variables yielded significant differences. This finding is consistent with expectations since under all of the methods the interpreter is "encouraged" to make all the identifications he possibly can without fear of impunity.

Table 2

MEAN PERFORMANCE INDICES FOR THREE METHODS OF STATING THE COMPLETENESS REQUIREMENT (T-17)

Method	Mean No. Correct	Mean No. Incorrect	Mean Accuracy
Payoff	39.8	21.9	65
Certitude	37.5	24.9	58
Verbal	40.3	24.7	62

Table 3 shows the same kind of data obtained under the accuracy and completeness requirement. As for the completeness requirement, the number of correct and incorrect identifications did not yield significant differences. However, the mean accuracy of identification did vary significantly among the three methods.

Table 3

MEAN PERFORMANCE INDICES FOR THREE METHODS OF STATING THE ACCURACY AND COMPLETENESS REQUIREMENT (T-10)

Method	Mean No. Correct	Mean No. Incorrect	Mean Accuracy*
Payoff	2.6	9.3	27
Certitude	2.9	11.9	51
Verbal	1.9	11.8	14

* Difference in mean accuracy significant at $P < .01$

Review of table 3 shows that the mean accuracy for the certitude method was approximately 3.5 times higher than that of the verbal method, and a little less than twice that of the payoff method. The mean accuracy of the certitude method was 51%. It might be expected that for this mean accuracy, a smaller mean number of incorrect identifications would have been obtained. However, the size of the mean number of incorrect identifications obtained for the certitude method is due primarily to the responses of two interpreters who were responsible for 90 of the 119 incorrect identifications made. Without such poor performance, the mean number of incorrect identifications made under the certitude method would undoubtedly have been significantly smaller and also significantly different from the other means. Such widely deviant behavior was not evident for the other two methods (See Appendix C). However, since mean accuracy was based on the mean of the individual accuracy scores and not on the total right and wrong identifications made by the group, the score

did not penalize the whole group for the adverse performance of a small number of individuals within the group.

The low mean accuracy of the verbal method may be attributed to the conflict engendered by the interpreter's attempting to perform under the conflicting requirements of accuracy and completeness. The low mean accuracy of the payoff method is a little puzzling. It is possible that the values of the awards (+ 1) and penalties (- 1) which were used were not large enough to induce the desired behavior. However, there are no data to guide the experimenter in the assignment of values for correct and incorrect performance to achieve the desired end. The study is therefore inconclusive with respect to the ability of the payoff method to yield information with the desired accuracy and completeness attributes. This can only be done by means of systematic research to determine which values function appropriately for a given military situation.

The analyses of variance failed to produce significant differences in interpreter performance under the accuracy requirement. However, as shown in table 4, there does appear to be a trend in the means of the accuracy with which the targets were identified. This trend favors the payoff method, followed in turn by the certitude and verbal methods. It is possible that the reason the mean accuracy of the certitude group was not higher was the considerable frequency with which interpreters tend to overestimate their confidence in the identifications which they make.

Table 4

MEAN PERFORMANCE INDICES FOR THREE METHODS OF STATING THE ACCURACY REQUIREMENT (T-23)

Method	Mean No. Correct	Mean No. Incorrect	Mean Accuracy
Payoff	2.6	1.3	77
Certitude	3.0	2.7	63
Verbal	2.2	3.2	46

The analysis of variance for the weighted accuracy scores for accuracy and completeness requirement and for the accuracy requirement failed to produce any significant results. Thus, it appears that the different methods of stating the requirements had little effect upon interpreter performance where such performance was evaluated in terms of quantitative values given, explicitly or implicitly, in the instructions. The mean weighted scores (Table 5) were negative indicating that the interpreters did not conform to the instructions in making their identifications.

Table 5

MEAN WEIGHTED SCORES FOR THREE METHODS OF STATING THE ACCURACY AND COMPLETENESS (T-10) AND ACCURACY (T-23) REQUIREMENTS

Method	INTERPRETATION REQUIREMENTS	
	Accuracy and Completeness (R = +1, W = -1)	Accuracy (R = +1, W = -9)
Payoff	-9.1	-6.7
Certitude	-11.3	-9.0
Verbal	-16.6	-9.9

Only two analyses of variance were computed, one for the accuracy and completeness requirement, and one for the accuracy requirement. The weighted scores for the completeness requirement were the same as the unweighted scores used in the unweighted analysis (X = 1, Y = 0); consequently, no additional analysis was required. Even though the differences in weighted scores were not significant for either requirement, the mean weighted scores for the payoff method were the highest for each requirement followed in order by those for the certitude method and the verbal method. All analyses of variance tables are included in Appendix E.

DISCUSSION AND CONCLUSIONS

The main purpose of the experiment was to determine whether interpreter performance was affected by presenting intelligence requirements for accuracy, completeness, and accuracy and completeness each in three different ways. Interpreter performance was scored in two ways. In addition to the three indices routinely obtained--number of correct identifications, number of incorrect identifications, and mean accuracy of identifications--a fourth index was used, a weighted score in which the weights were the values assigned to rights and wrongs scores under the payoff method of presenting information requirements.

Nonsignificant results were obtained for the three regular indices of interpreter performance when the interpreter was operating under two of the three requirements, accuracy and completeness. For the weighted scores also, results were nonsignificant for accuracy and for the accuracy and completeness combined. However, the significant result for mean accuracy of identifications under the combined accuracy and completeness requirement offers some hope for the certitude method as possibly useful for stating intelligence requirements, particularly where conflicting requirements for completeness and accuracy are imposed simultaneously. As noted earlier, the additional important

requirements for timeliness and level of reporting detail were not included in the study. Inclusion of these requirements in future research may well influence the direction of the results of studies such as this.

Past research has shown that the interpreter consistently overestimates his confidence in his identifications. However, with additional training in estimating his confidence, it is postulated that the interpreter's expressed judgment of the probability of his identification being correct may be more closely related with the accuracy of his identifications. Should this be the case, then the certitude method should certainly be one of the promising methods to be considered in future research.

The payoff method also shows promise as a method of stating intelligence requirements. The relative poor performance obtained for the unweighted scores under accuracy and completeness requirement may be a function of the values employed. Under the accuracy requirement, this method yielded the highest mean accuracy of the three methods, and just missed being significantly different from the other methods. Although the means were not significantly different for the weighted scores, there was a trend for the payoff method to have the highest scores under the accuracy and completeness and accuracy requirements. Further research using different values may provide more significant findings. Further, it is possible that a combination of the payoff and certitude methods may serve as a potential optimal method, since for some requirements the payoff method may be more productive, and for others the certitude method. Future research will explore this possibility.

Generally speaking, the verbal description of the requirements appeared to be the least effective of the three methods. Such performance for the completeness requirement and for the accuracy requirement could be due to the lack of a standard frame of reference generally applicable to each of the requirements, and also to different connotations engendered among different interpreters regarding the precise meaning of each of the requirements. The poor performance under the accuracy and completeness requirement typifies the results obtained when interpreters work under simultaneously imposed conflicting requirements.

Note that completeness was a dependent variable that required analysis in the contextual setting of this study. Since the completeness score normally used is a ratio of rights over rights plus wrongs plus misidentifications (where rights plus wrongs plus misidentifications equal K or the total number of targets in the performance measure and is a constant for all subjects for a given performance measure), the number of rights is a perfect correlate of completeness. Thus, only number of rights was used in the study.

However, in some information requirements an item of concern is a detection accuracy score which is a function of the complement of the number of omits. A ratio representing this score would be expressed as a ratio of rights and misidentifications over K where K equals the

total number of targets in the scoring key. Although an analysis of this variable was not conducted in this exploratory investigation, it will be included as one of the more important variables in a more comprehensive study.

The major implication of the experiment is that different methods of stating requirements have an effect on performance, and that the certitude method (i.e. requiring the interpreter to identify only those targets for which his level of confidence is 50% or better) appears to be one promising method of stating requirements when conflicting requirements of completeness and accuracy are imposed simultaneously.

APPENDIXES

A-1. INSTRUCTIONS FOR COMPLETENESS REQUIREMENT

General Military Situation

Higher headquarters is planning an airborne drop of a battle group in an area adjacent to your zone of responsibility. Due to the nature of the mission, all enemy objects must be reported. Before the drop zone is selected all possible targets should be located and identified. Your mission is to locate and identify all possible military targets.

Instructions for Method A (Payoff Method)

Your performance will be evaluated as follows: You will receive one point for each correct identification. Errors will not count against you. Your total score therefore depends entirely on the number of correct identifications you make.

Instructions for Method B (Certitude Method)

Therefore, identify all possible military targets even though your level of confidence in your identifications may be near zero.

Instructions for Method C (Verbal Method)

Therefore, be as complete as possible in your identifications and identify all possible military targets.

A-2. INSTRUCTIONS FOR ACCURACY AND COMPLETENESS REQUIREMENT

An armored attack is being planned for the area of your zone of responsibility. It is important that all areas of enemy military activity be located.

Your mission is to locate and identify all military targets, but at the same time, try not to make any erroneous identifications.

Instructions for Method A (Payoff Method)

To stress the importance of maintaining a balance between accuracy and completeness your performance will be evaluated as follows: You will get one point for each correct identification, however, you will also lose a point for each error you make.

Instructions for Method B (Certitude Method)

Therefore, only identify those objects for which your level of confidence in your identification is 50% or better.

Instructions for Method C (Verbal Method)

Therefore, be as complete as possible in your identifications, but at the same time be as accurate as possible.

A-3. INSTRUCTIONS FOR ACCURACY REQUIREMENT

General Military Situation

The U. S. military units opposing enemy units in your zone of responsibility are under strength and low on supplies, particularly ammunition. To avoid possible waste of ammunition and other supplies priority must be given to those objects which can be clearly identified.

Your mission is to locate and identify only those objects which you are certain contain military targets.

Method A (Payoff Method)

To stress the importance of avoiding errors your performance will be evaluated as follows: You will get one point for each correct identification, but you will lose 9 points for each incorrect identification.

Method B (Certitude Method)

Therefore, only identify those objects for which your level of confidence in your identification is 90% or better.

Method C (Verbal Method)

Therefore, be very accurate, as accurate as you can possibly be, in making your identifications.

B-1. PERSONNEL RESEARCH BRANCH
IMAGE INTERPRETATION PERFORMANCE TEST

PACKET NR: T-10

CONTENTS: Situation Sheet, answer sheet, photos 8 to 14 from Mission R474B 16 August 1950, map sheet 6822 II (INDONG, scale 1:50,000), sortie plot overlay, objects list

GENERAL SITUATION:

You are a member of the 25th Infantry Division PI team in Korea in August 1950. The NKPA has increased pressure both north and east of TAEGU. The front now extends from KWAN-DONG to HAKSONG-DONG in your division sector. (see Map) It is expected that the enemy soon will attempt major attacks in this area in order to secure the important transportation center of TAEGU southeast of your present positions.

SPECIFIC SITUATION:

The Division G-2 Air has requested that your PI team report on all enemy activity along the NAKTONG-GANG (River). Your team chief has assigned the area covered by photos 9 to 13 of the latest photo mission received. He has determined the scale to be approximately 1:7,000.

REQUIREMENTS:

Report all of the following items:

Vehicles
Artillery
Fortifications

In identifying the objects on your answer sheet use only those names appearing on the attached objects list.

You have 50 minutes to complete this task.

B-2.

HUMAN FACTORS RESEARCH BRANCH
IMAGE INTERPRETATION PERFORMANCE TEST

PACKET NR: T-17

CONTENTS: Situation Sheet, Answer Sheet, Photos 1-7 from Mission 1500 F22, and Sortie Plot

GENERAL SITUATION:

The date is 29 October 1960. You are an image interpreter in a PI Company attached to a STRAC unit in CONUS. Hostile forces have established a beachhead on the eastern coast of Florida and air dropped special forces 20 miles inland. The air dropped special forces have disrupted communications and captured unknown quantities of U. S. Army equipment.

SPECIFIC SITUATION:

Hostile forces have been reported in the area covered by the photographs in your packet.

REQUIREMENTS:

Report all military objects appearing on the object list which you can locate and identify on the aerial photographs. Use only those terms appearing on your object list.

B-3. U. S. ARMY PERSONNEL RESEARCH OFFICE
WASHINGTON, D. C. 20315

PERFORMANCE MEASURE: T-23 IMAGE INTERPRETATION TASK

CONTENTS: Situation Sheet; Immediate Report Form; Photos 1037-1042 from Mission US 30-4488

GENERAL SITUATION:

You are assigned to the Immediate Interpretation Platoon of the Photo Interpretation Support Unit attached to the US First Army. The Allied Forces landed on the Normandy Peninsula on 6 June 1944 and for the next six weeks expanded their lodgement area in preparation for a concentrated attack. The breakout was successful and the First Army moved beyond St. Lo. Just recently the Third Army attacked South and West, securing most of Brittany.

SPECIFIC SITUATION:

Last week the First Army easily captured Mortain but German forces counter-attacked successfully two days ago. The situation has remained the same except for a partially successful enemy drive in their northern sector yesterday. Your unit has received photographs flown three hours ago (scale 1:10,750) and artillery in the area of enemy penetrations has been given top priority. You have been assigned part of the photos received.

REQUIREMENTS:

Locate and identify:

(Arty)	Groups of 3 or more FA or AA positions whether occupied or not
(Tank)	Concentrations of 3 or more tanks and/or SP guns <u>not</u> on the road
(Wheeled V)	Concentrations of wheeled vehicles (3 or more) <u>not</u> on the road
(Wheeled V-road)	Concentrations of wheeled vehicles (3 or more) on the road
(Tank-road)	Concentrations of 3 or more tanks and/or SP guns on the road

PERFORMANCE MEASURE: T-23

1. A concentration of tracked or wheeled vehicles is defined here as 3 or more occuring within an area of about 250 by 250 meters (approximately one square inch on your photographs).

2. A concentration of tracked or wheeled vehicles on the road consist of a group of 3 or more, each being within one inch of the preceding vehicle.

3. Indicate the location of required items on your photograph by placing an "X" in the center of a battery or in the center of a concentration of tracked or wheeled vehicles either on or off the road. Do not report individual tracked vehicles, wheeled vehicles, or guns. Report only concentrations of vehicles and batteries and indicate the number of vehicles and guns in each.

4. Use only the abbreviations given above under requirements in identifying the objects on your Spot Report Transmittal Form.

5. You will have 25 minutes to complete your report.

C-1. RAW SCORE DISTRIBUTIONS OBTAINED ON T-10 UNDER THE ACCURACY AND COMPLETENESS REQUIREMENT

Method A				Method B				Method C			
Man	R	W	Acc	Man	R	W	Acc	Man	R	W	Acc
1	2	0	100	11	3	0	100	21	3	7	30
2	1	8	11	12	1	0	100	22	0	8	0
3	0	10	0	13	4	0	100	23	1	7	12
4	5	4	56	14	2	1	67	24	5	18	22
5	5	8	38	15	1	48	2	25	3	10	23
6	9	23	28	16	3	9	25	26	2	11	15
7	0	16	0	17	1	10	9	27	1	15	6
8	0	4	0	18	6	3	67	28	2	7	22
9	0	14	0	19	3	6	33	29	2	24	8
10	4	6	40	20	5	42	11	30	0	11	0
Σ	26	93	273	Σ	29	119	514	Σ	19	118	138

C-2. RAW SCORE DISTRIBUTIONS OBTAINED ON T-17 UNDER THE COMPLETENESS REQUIREMENT

Method A				Method B				Method C			
Man	R	W	Acc	Man	R	W	Acc	Man	R	W	Acc
1	50	12	81	11	44	33	57	21	73	34	68
2	43	17	72	12	56	15	79	22	34	12	74
3	27	33	45	13	27	24	53	23	31	10	76
4	64	15	81	14	33	22	60	24	38	49	44
5	36	41	47	15	40	28	59	25	31	22	58
6	25	6	81	16	37	22	63	26	53	19	74
7	20	24	45	17	4	28	12	27	36	30	55
8	38	10	79	18	48	21	70	28	56	29	66
9	24	19	56	19	37	15	71	29	36	13	73
10	71	42	63	20	49	41	54	30	15	29	34
Σ	398	219	650	Σ	375	249	578	Σ	403	247	622

C-3. RAW SCORE DISTRIBUTIONS OBTAINED ON T-23 UNDER THE ACCURACY REQUIREMENT

Method A				Method B				Method C			
Man	R	W	Acc	Man	R	W	Acc	Man	R	W	Acc
1	2	0	100	11	3	0	100	21	1	4	20
2	3	1	75	12	5	0	100	22	3	0	100
3	3	5	38	13	3	0	100	23	5	2	71
4	5	1	83	14	2	3	40	24	2	3	40
5	1	2	33	15	2	6	25	25	1	3	25
6	1	1	50	16	2	8	20	26	2	4	33
7	2	0	100	17	3	6	33	27	1	5	17
8	3	0	100	18	4	2	67	28	3	0	100
9	1	0	100	19	4	1	80	29	4	4	50
10	5	3	88	20	2	1	67	30	0	7	00
Σ	26	13	767	Σ	30	27	632	Σ	22	32	456

D-1. WEIGHTED SCORE DISTRIBUTION OBTAINED ON T-10 UNDER THE ACCURACY AND COMPLETENESS REQUIREMENT (R = +1, W = -1)

Method A		Method B		Method C	
Man	Score	Man	Score	Man	Score
1	2	11	3	21	-4
2	-7	12	1	22	-8
3	-10	13	4	23	-6
4	1	14	1	24	-13
5	-3	15	-47	25	-7
6	-14	16	-6	26	-9
7	-16	17	-9	27	-14
8	-4	18	3	28	-5
9	-14	19	-3	29	-22
10	-2	20	-37	30	-11
	Σ -67		Σ -90		Σ -99

D-2. WEIGHTED SCORE DISTRIBUTIONS OBTAINED ON T-23 UNDER THE ACCURACY REQUIREMENT (R = +1, W = -9)

Method A		Method B		Method C	
Man	Score	Man	Score	Man	Score
1	2	11	3	21	-35
2	-6	12	5	22	3
3	-42	13	3	23	-13
4	-4	14	-25	24	-25
5	-17	15	-52	25	-26
6	-8	16	-70	26	-34
7	2	17	-51	27	-44
8	3	18	-14	28	3
9	1	19	-5	29	-32
10	-22	20	-2	30	-63
	Σ -91		Σ -113		Σ -166

E. ANALYSIS OF VARIANCE TABLES

VARIABLE	SOURCE	SUM OF SQUARES	d.f.	MEAN SQUARE	F
	Completeness Requirement T-17				
Rights	Between Gps.	44.60	2	22.30	.086
	Within Gps.	6976.20	27	258.30	
Wrongs	Between Gps.	56.27	2	28.14	.228
	Within Gps.	3337.90	27	123.63	
Accuracy	Between Gps.	263.47	2	131.74	.509
	Within Gps.	6993.20	27	259.01	
	Accuracy and Completeness Requirement T-10				
Rights	Between Gps.	3.20	2	1.60	.829
	Within Gps.	52.00	27	1.93	
Wrongs	Between Gps.	19.40	2	9.70	1.820
	Within Gps.	143.80	27	5.33	
Accuracy	Between Gps.	4864.07	2	2432.04	2.49
	Within Gps.	26362.10	27	976.37	
Weighted	Between Gps.	1610.60	2	805.30	1.786
	Within Gps.	12171.40	27	450.30	
	Accuracy Requirement T-23				
Rights	Between Gps.	5.27	2	2.64	.539
	Within Gps.	132.20	27	4.90	
Wrongs	Between Gps.	43.40	2	21.70	.164
	Within Gps.	3576.60	27	132.47	
Accuracy	Between Gps.	7256.07	2	3628.04	3.910 *
	Within Gps.	25072.10	27	928.60	
Weighted	Between Gps.	54.47	2	27.24	.206
	Within Gps.	3573.00	27	132.33	

*p(.01)